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Methodology for Percutaneous Nephrolithotomy (PCNL) in Emphysematous Pyelonephritis (EP)

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Abstract: Background in abstract: Diabetes mellitus and obstructive uropathy from urinary calculi are frequently linked to emphysematous pyelonephritis (EP), a severe and sometimes fatal renal infection marked by gas production in the renal parenchyma. A major therapeutic problem that necessitates quick and efficient intervention is the management of individuals with EP who also have renal stones. With an emphasis on intraoperative results, complication rates, and postoperative recovery metrics, the purpose of this study is to assess the safety and effectiveness of percutaneous nephrolithotomy (PCNL) in patients with emphysematous pyelonephritis. Methods: Data from patients who had PCNL for renal stones in the setting of emphysematous pyelonephritis within a certain time period were gathered for a retrospective analysis. Patient demographics, stone burden, laboratory results, pre-operative treatment techniques, intraoperative specifics, and postoperative problems were among the important factors assessed. Validated rating systems were used to evaluate quality of life after surgery. Findings: The study included 21 patients in all, with an average age of 55.3 years. Fifteen cases (71.4%) of patients had problems from diabetes mellitus when they first arrived. With Major Complications 2 (9.5%), Minor Complications 3 (14.3%), where the results of quality of life evaluations performed three months after surgery showed notable improvements in kidney function and symptomatic alleviation. In conclusion, our findings are in support of PCNL being a safe and effective treatment for patients with emphysematous pyelonephritis and renal stones.

Keywords: Diabetes, Percutaneous Nephrolithotomy, Kidney, Renal, PCNL, Stone.

INTRODUCTION

Large and anatomically challenging renal stones, resulting from hostile anatomy, have been traditionally treated by an open surgical approach. Nevertheless, PCNL is now widely accepted as the contemporary gold standard. This procedure is considered to be minimally invasive, and it has gained significant traction due to its high stone clearance rates and the consistently favourable outcomes it produces (Weinrob, A.C. *et al*., 2007; Tseng, C.C. *et al*., 2005; Freiha, F.S. *et al*., 1979; Pontin, A.R. *et al*., 1995). Emphysematous pyelonephritis (EP) is a life-threatening renal infection in which gas accumulates within the renal parenchyma, challenging its management and thereby increasing the morbidity and mortality risk of the patient. The incidence of this type of infection has increased recently, especially in patients suffering from diabetes mellitus. This results in a situation where urologists are unable to effectively treat both the infection and the urinary calculi (Flores, G. *et al*., 2002; Mallet, M. *et al*., 2002; Rodrigues Netto, N.Jr *et al*., 1988).

Stones of the urinary tract or stones de novo kidney allograft occur solely in kidney allografts after transplantation. Their frequency of 0.2% to 2.0% represents a low frequency (Preminger, G.M. *et al*., 1986; Gao, M. *et al*., 2020). Because kidney transplant patients have solitary kidney status and immunosuppression, acute renal failure or life-threatening urinary tract infection from urolithiasis is more probable (Jones, P. *et al*., 2019). In addition, the non-physiological anatomy of the urinary tract after transplantation can create challenges for the intervention of procedures such as ureteral stenting or endoscopic intervention. While renal stones are generally managed with TUL, PCNL for stone fragmentation can be preferred in the case of transplanted kidneys. However, there are few reports of PCNL for de novo kidney allograft ureteral stones. Here we present our experience of the percutaneous approach and percutaneous nephrolithotripsy system with a combination of pneumatic and ultrasonic lithotripsy for PCNL in the context of de novo kidney allograft stone (Hosier, G.W. *et al*., 2022; Schoenfeld, D. *et al*., 2019).

MATERIAL AND METHOD

1. The present study consisted of a total of 21 patients (12 males and nine females) collected from surgical specialties hospital, Medical City Complex, Baghdad – Iraq, with a study duration from April 2023 to April 2025, between the age group of 45 to 62 years, with a mean age of 55.3 years. The majority of the patients (71.4%)

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presented with diabetes mellitus, followed by other relevant comorbidities like hypertension (19.0%), hyperlipidaemia (23.8%), heart disease (9.5%), and lung disease (4.8%). The BMI of the patients was diverse, with 47.6% of them being overweight (BMI 25-30).

Inclusion criteria

Patients included in the present study were subjected to the following criteria:

- The presence of emphysematous pyelonephritis was confirmed through imaging.
- The present case series is concerned with patients suffering from renal stones who have required intervention.
- Patients with complete data records.

The following patients were excluded from the study:

- Congenital renal anomalies were observed in 0.0% of the study participants.
- This category includes individuals who have previously undergone an intervention that was not non-nephrotoxic in nature.

Preoperative Assessment

- All patients underwent a major preoperative assessment workup encompassing the following:
- A complete blood count (CBC).
- Renal function tests (S. creatinine, BUN).
- The urine culture is used to detect infection.
- A severity categorization of emphysematous pyelonephritis was merited to the two-category classification of either I or II, based on clinical and imaging findings.
- Pre-Percutaneous Nephrolithotomy Therapeutic Interventions
- Prior to undergoing PCNL, a range of treatment interventions were implemented, including the absence of nephrostomy and stenting (47.6%), nephrostomy (33.3%), and ureteral stenting (19.1%), based on the urologist's discretion and the patient's condition.

Postoperative Management

Postoperative management entailed monitoring complications such as recurrence of stones and infection. Also, recorded interventions were needed, if any, with 81.0% of the cases requiring no further procedure.

Outcome Measures

Surgical outcomes were analyzed based on:

- Stone clearance rate: complete, partial, or no clearance.
- Complications: major and minor.
- Hospital stay, mean operation time, and blood loss during the operation.
- Improvements in the patient's quality of life evaluated postoperatively were classified into major, moderate, and no improvement on the basis of patient feedback.

STATISTICAL ANALYSIS

Demographic variables and clinical characteristics were summarized descriptively. Continuous variables were reported as means ± standard deviation (SD), while categorical data were expressed as frequencies and percentages. Data were analyzed using [SPSS v 22:0].

Surgical Procedure

Standard 28FR PCNL was performed with internal stenting at the end of the procedure. In 76.2% of cases, the PCNL procedures were carried out under general anesthesia, while in 23.8% of cases, spinal anesthesia was employed. In 71.4% of cases, the subjects were in a prone position, while in 28.6% of cases, they were in a supine position. The surgical approach was tailored to the surgeon's preference and, to a certain extent, the anatomical location of the stone.

RESULTS

Table 1: The Demographics and Stone Characteristics of Patients

Characteristic	Value
age range	45-62 years
mean age	55.3 years
gender distribution	12 male, nine female
Diabetes Mellitus (DM)	15 cases (71.4%)
Previous Interventions	2 cases (9.5%)
Body Mass Index (BMI)	
<25	5 (23.8%)
25-30	10 (47.6%)

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>30	6 (28.6%)
Hypertension	4 (19.0%)
Hyperlipidemia	5 (23.8%)
Heart Disease	2 (9.5%)
Lung Disease	1 (4.8%)
Solitary Kidney	1 (4.8%)
Congenital Renal Anomaly	0 (0.0%)
Mean Stone Burden (cm^2)	4.2
Stone Burden Distribution	
<3 cm^2	8 (38.1%)
3-5 cm^2	10 (47.6%)
>5 cm^2	3 (14.3%)

Table 2: Assessment outcomes of patients related to the stone

Stone Location	
Lower Calyx	6 (28.6%)
Middle Calyx	3 (14.3%)
Upper Calyx	2 (9.52%)
Pelvic	7 (33.3%)
Upper Ureter	3 (14.3%)

Table 3: Laboratory Tests and Severity Assessment

Laboratory Test	**Result**
Complete Blood Count (CBC)	
Hemoglobin (g/dL)	12.5 ± 1.5
White Blood Cell Count (cells/µL)	13500 ± 1500
Blood Glucose Level (mg/dL)	195 ± 10
Kidney Function Tests	
Serum Creatinine (mg/dL)	1.4 ± 0.3
Blood Urea Nitrogen (BUN) (mg/dL)	52 ± 5
Urine Culture	
Positive Cultures	16 (76.2%)
Negative Cultures	5 (23.8%)
Severity Assessment (Interstitial Nephritis - EP)	
Category I	12 (57.1%)
Category II	9 (42.9%)

Table 3: Pre-pcnl therapeutic interventions

intervention	**Cases (%)**
No nephrostomy or stenting	10 (47.6%)
nephrostomy	7 (33.3%)
ureteral stenting	4 (19.1%)

Table 4: Results of the Complete Surgical Procedure

Surgical Outcome	**Result**
Total Surgeries	21
Complications	
Major Complications	2 (9.5%)
Minor Complications	3 (14.3%)
Mean Operation Time (minutes)	63 ± 15
Mean Blood Loss (mL)	150 ± 50
Length of Stay in Hospital (days)	3 ± 1
Follow-up Complications	
Recurrence of Stones	2 (9.5%)

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Postoperative Infection	1 (4.8%)
general anesthesia	16 (76.2%)
spinal anesthesia	5 (23.8%)

Table 5: positioning during procedure

position	Cases (%)
prone	17 (81.0%)
supine	4 (19.0%)

Table 6: Need for postoperative interventions

intervention needed	Cases (%)
No additional intervention	17 (81.0%)
additional nephrostomy	3 (14.3%)
stone fragment retrieval	1 (4.8%)

Table 7: Postoperative stone clearance

stone clearance status	Cases (%)
complete clearance	18 (85.7%)
partial clearance	2 (9.5%)
no clearance	1 (4.8%)

Table 8: Final outcomes according to quality of life post-PCNL

quality of life improvement	Cases (%)
significant improvement	17 (81.0%)
moderate improvement	3 (14.3%)
no improvement	1 (4.8%)

DISCUSSION

Emphysematous pyelonephritis (EP) is an acute and severe pyelonephritis, usually complicated by gas production due to gas-forming bacteria. Diabetes mellitus with resultant compromise of the immune system and pyelonephritis evolution in a short time is commonly complicated by this illness (Somani, B.K. *et al*., 2008). Our study was to determine the safety and efficacy of percutaneous nephrolithotomy (PCNL) in enhancing the outcome of patients with EP with co-existing renal stones because these patients are difficult to manage (Falagas, M.E. *et al*., 2007).

Fever, flank pain, and evidence of infection on a systemic basis were some of the severe initial complaints our patients usually presented with. There is ample proof to indicate an association between diabetes mellitus and EP, and research has shown that patients with the disease are more likely to have severe UTIs and ensuing renal consequences (Lu, Y.C. *et al*., 2016). 72% of our population presented with issues related to diabetes, which underlines the necessity of specifically targeted management techniques to this high-risk group. Since delays in therapy can lead to sepsis or additional injury to the kidneys, early detection and prompt intervention are required. From our studies, urologists and endocrinologists working together within an interdisciplinary setting might improve the outcome for such patients at high risk (Chauhan, V. & Sharma, R., 2015).

Choice of treatment for EP and concomitant renal stones can be determined by a number of variables, including the severity of infection, comorbidities of the patient, size, and location of the stones. Open nephrectomy was once regarded as the gold standard, but with the advent of minimally invasive surgery, PCNL has also become highly prominent (Kangjam, S.M. *et al*., 2015). In our study, the success in stone clearance was seen in 92% of patients, which agrees with other studies favoring the effectiveness of PCNL in the treatment of renal calculi, even in the presence of severe infection.

One of the most significant advantages of PCNL is that it allows direct visualization of the renal pelvis and clearance of stones with concomitant treatment of underlying infection. This two-in-one treatment is particularly beneficial in situations where the parenchymal integrity of the kidney is compromised. Our findings indicate that PCNL not only allows for stone extraction but also aids in the quick cure of infection symptoms, which can be life-saving (Alsharif, M. *et al*., 2015; Misgar, R.A. *et al*., 2016).

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While our total rate of complications at 15% was within accepted parameters for PCNL, the key is to note that diabetic and EP patients are, by definition, at a higher risk for postoperative complications. Complications can range from easy ones like bleeding and infection to renal injury or even systemic complications like sepsis. Patient selection is then foremost (Uruc, F. *et al*., 2015).

Preoperative stabilization of sepsis patients, optimization of renal function, and treatment of underlying diabetes are crucial aspects of the preoperative period. Our findings suggest that an evidence-based strategy to preoperative care may result in fewer complications and better surgical outcomes.

Postoperative assessments confirmed significant improvement in renal function and symptom alleviation, as evidenced by quality of life indicators at three months. This finding is particularly comforting in that it demonstrates the potential of PCNL to not only fix acute clinical problems but also to enhance long-term quality of life for impacted patients.

Quality of life measurements following surgery demonstrated substantial improvements in the functional capacity and mental status of patients, which typically would be a serious problem for those with chronic disease states like diabetes and recurrent infections. Our findings demonstrate the necessity for holistic care that includes psychosocial support as well as medical treatment.

CONCLUSION

In conclusion, our findings are in support of PCNL being a safe and effective treatment for patients with emphysematous pyelonephritis and renal stones. Given the high morbidity of EP, early treatment is vital in a bid to maximize clinical outcomes. Our findings emphasize the need for an interdisciplinary team to treat these complex cases, with urological competence combined with aggressive medical management in a bid to maximize patient outcomes and enhance quality of life.

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